Effects of cow milking order on access to pasture and milk production in an automatic milking system

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Short title: Cow milking order in AMS

Abstract

Little is known about the consistency of milking order in automatic milking systems (AMS) with voluntary cow movement and how this can influence the characteristics of pasture on offer to cows in the herd. This study utilized cow records from a split-calving herd of 156 dairy cows in a pasture-based AMS in Victoria during November 2017 to establish the milking order and its relationship with milk production. In addition, pasture mass and quality were measured every 2 hours during the morning grazing on 28-29 November 2017 and used in GrazFeed to predict the effects of changing pasture characteristics on milk production. Milking time records demonstrated that there were groups of approximately 20 cows that were consistently ‘early’ or ‘late’ in the milking order. Average energy corrected milk production of ‘early’ and ‘late’ cows was 36.4 and 29.3 kg/day, respectively. ‘Early’ cows entered the pasture at an average mass of 3,250 kg DM/ha and consumed pasture with 10.4 MJ Metabolizable Energy (ME)/kg DM, while ‘late’ cows entered at 1,850 kg DM/ha and consumed pasture with 9.9 MJ ME/kg DM. GrazFeed modelling of cows in early lactation consuming 7.6 kg DM/day pellets and offered pasture with the average mass and DMD at time of entry of ‘early’ and ‘late’ cows, predicted that ‘early’ cows would produce 2.1 kg/day more milk than ‘late’ cows (31% of the measured difference). This research highlights the important role that the interactions between pasture characteristics and cow grazing behavior play in determining milk production from animals within the herd.

Introduction

On most Australian dairy farms, cows obtain the majority of their energy requirements from pasture (Jacobs 2014). Pasture is generally offered to the herd in a rotational grazing system with two or three allocations per day, usually after milking, with the pasture being consumed by the herd over a period over several hours. It is well established that cows can maximize bite mass and pasture intake rate with a higher sward herbage mass (Barrett et al. 2002). Additionally, pasture nutritive characteristics change with sward height, with protein and metabolizable energy levels being higher at the top of the sward and declining down through the canopy (Delagarde et al. 2000; Cullen et al. 2017). Thus, cows that enter the pasture early in the grazing allocation are advantaged because they can maximize pasture intake rate and select pasture with higher nutritive value. By contrast, cows that enter the pasture later will be limited in both aspects, and these differences may have important implications for milk production. Beggs et al. (2017) showed that milking order in pasture-based dairy systems is quite consistent even in large herds, particularly at the start (‘early’) and end (‘late’) of milking. These ‘early’ cows tend to have higher milk production than ‘late’ cows (Scott et al. 2014), but the extent to which this difference in production is related to access to pasture, or other factors such as genetic or behavioural differences, is not known. The aim of this research was to determine (1) the consistency of milking order in a pasture-based system where cows move voluntarily between pasture and the milking parlour; (2) how pasture mass and nutritive characteristics change during a grazing allocation; and (3) how different pasture characteristics will impact in the milk production of cows that are early or late in the milking order.
Materials and Methods

Dairy farm system

The experiment was conducted at The University of Melbourne, Dookie campus robotic dairy in northern Victoria, Australia. The farm consists of 41 ha of border check irrigated perennial ryegrass-based pastures, with another 15 ha of dryland pasture and cereal crops for grazing. The farm has a milking herd of 156 Holstein Friesian cows, with approximately 60% calving in spring and the remainder in autumn. Cows were milked through three Lely Astronauts robotic milking units, with voluntary cow movement through three grazing areas to facilitate a target milking frequency of three times per day.

In addition to grazed pasture, in the month of November 2017 when this experiment was conducted, the cows were offered 7.6 kg DM/day of concentrate feed in the AMS which had 16% crude protein (CP) and 12.5 MJ ME/kg DM. The estimated daily average pasture intake in the month was 13.5 kg DM/cow.

Pasture and cow entry measurements

Pasture mass and nutritive characteristics were measured during the morning grazing allocation on two consecutive days (29-30 November 2017). On each day pasture mass was measured using a calibrated electronic plate meter every hour from the time that the first cow entered the paddock to the time that the last cow entered (5:20-11:30 am). Every second hour, grab samples of pasture from 20 locations in the paddock were collected for analysis of nutritive characteristics. These samples were collected from the area and plant parts that the herd was grazing at the time of sampling, rather than an average of the pasture available, to give an indication of what the cows were consuming at each point in time. The pasture samples were dried on the oven at 60°C for 72 hours, ground, and analysed by near-infrared spectroscopy for CP and ME at the laboratory of New South Wales Department of Primary Industries, Pine Gully Road, Wagga Wagga.

The time of entry of each cow into the grazing paddock, as well as the total number of animals grazing, was recorded throughout the grazing allocation.

Milking time and milk production

Milking time of each cow was recorded by the automatic milking system and used to determine the daily rank order of cows in November 2017. Cows that were consistently ‘early’ or ‘late’ in the milking order were identified using the average and variance of daily rankings. Daily milk production records (milk yield in kg/day, fat and protein in percentages) for the ‘early and late’ cows were extracted for the month of November and used to determine the milk production differences between these groups. In addition to control for differences in genetic merit and lactation stage, the milk production of an ‘average’ cow in the herd at 60-days in milk was predicted using GrazFeed (Freer et al. 1997) for the ‘early’ and ‘late’ cows using pasture characteristics at the start and end of the grazing allocation and feeding 7.6 kg DM/cow of concentrates.

Results and Discussion

Milking time records demonstrated that there were groups of cows that were consistently ‘early’ and ‘late’ in the milking order, as evidenced by the relatively low variability in their rank order for cows below the 30th percentile of mean rank position and above the 70th percentile (Figure 1). This finding is consistent with Beggs et al. (2017). In this study, average energy corrected milk production of ‘early’ and ‘late’ cows was 36.4 and 29.3 kg/day during November 2017, respectively.

Figure 1. Mean rank percentile position of individual cows versus variance for a herd of 156 cows in November 2017.
On both 29th and 30th November, pasture mass decreased through the grazing cycle as the number of cows in the paddock increased up to a maximum of 90 cows (Figure 2). Pasture nutritive characteristics (CP and ME) also declined through the grazing allocation, but this was more pronounced for CP compared to ME and larger on the 29th November compared to 30th November (Figure 3).

Figure 2. Pasture mass and number of cows in the paddock at 1-hourly intervals during the grazing allocation on the mornings of 29 and 30 November 2017.

![Graph showing the relationship between pasture mass and number of cows with time, indicating a decrease in pasture mass and an increase in the number of cows over time.](image-url)
‘Early’ cows entered the pasture at an average mass of 3,250 kg DM/ha and consumed pasture with 10.4 MJ ME/kg DM, while ‘late’ cows entered at 1,850 kg DM/ha and consumed pasture with 9.9 MJ ME/kg DM (Figures 2 and 3). GrazFeed modelling of cows in early lactation consuming 7.6 kg DM/day pellets and offered pasture with the average mass and DMD at time of entry of ‘early’ and ‘late’ cows, predicted that ‘early’ cows would produce 2.1 kg/day more milk than ‘late’ cows. This represented 31% of the measured milk production difference between the two groups. Other differences between the groups were that ‘early’ cows tended to have fewer days in lactation and had higher milking frequency which also would have contributed to their higher milk production.

This research highlights the important role that the interactions between pasture characteristics and cow grazing behaviour play in determining milk production from animals within the herd. However, this research was conducted on one farm for a period of one month and further research is required to confirm the patterns of milking order, pasture depletion and milk production across a range of production systems before recommendations for any management changes can be made.

References


